

Improved Attachment Design for Ceramic Turbine Blades Via Hybrid Concepts, Phase I

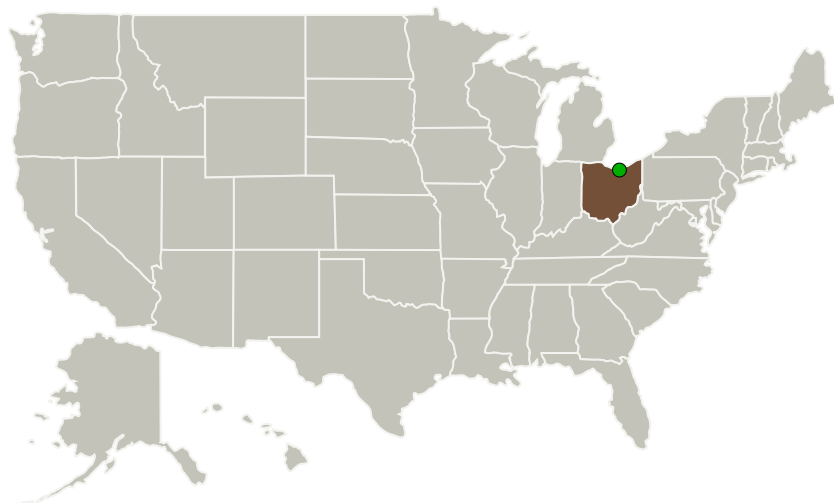
Completed Technology Project (2014 - 2014)



Project Introduction

This proposal presents a hybrid metal-CMC turbine blade. A SiC/SiC CMC airfoil section will be bonded to a single crystal superalloy root section in order to mitigate risks associated with an all-CMC blade inserted in a superalloy disk. This allows current blade attachment technology (SX blade with a dovetail attachment to a slotted Ni disk) to be used with a ceramic airfoil. The bond between the CMC and single crystal will be primarily mechanical in nature, and enhanced with clamping arising from thermal expansion mismatch. Two single crystal root sections will be bonded to each other using diffusion bonding and/or transient liquid phase bonding at temperatures near 2200 0F. The single crystals will form a clam shell around the CMC, with little or no gap between the metal and ceramic. Upon cooling, the metal will shrink around the CMC spar to firmly clamp it. Single crystals will resist stress relaxation at an operating temperature of 1500 0F, thus maintaining clamping loads for long lives. The use of an inter layer ("compliant layer") between the CMC and the single crystal may also be entertained. 1500 0F is a reasonable upper limit for chemical reactivity issues between the metal and ceramic.

Primary U.S. Work Locations and Key Partners



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Organizations Performing Work	Role	Type	Location
N&R Engineering	Lead Organization	Industry Small Disadvantaged Business (SDB)	Parma Heights, Ohio
● Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio

Primary U.S. Work Locations

Ohio

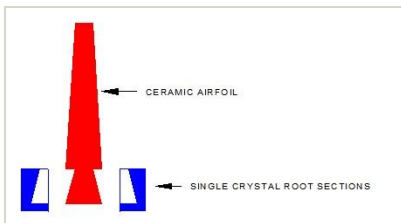
Project Transitions

**June 2014:** Project Start**December 2014:** Closed out

Closeout Documentation:

- Final Summary Chart(<https://techport.nasa.gov/file/137775>)

Images



Briefing Chart

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(<https://techport.nasa.gov/image/133055>)

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

N&R Engineering

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

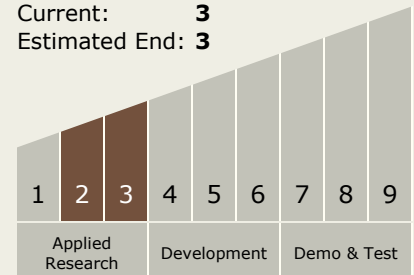
Carlos Torrez

Principal Investigator:

Kathy Paulitzky

Technology Maturity (TRL)

Start: 2
Current: 3
Estimated End: 3



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Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
 - └ TX12.2 Structures
 - └ TX12.2.1 Lightweight Concepts

Target Destinations

The Moon, Mars, Outside the Solar System, The Sun, Earth, Others Inside the Solar System